Niagara Ship Canal

Report

of

Charles E. Blunt

1868

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40th Congress, 2d Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. No. 197.

NIAGARA SHIP CANAL.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

Report by Colonel Blunt, on the surveys for a ship canal to connect Lakes Erie and Ontario.

March 3, 1868.—Referred to the Select Committee on the Niagara Ship Canal.

War Department,
Washington City, March 3, 1868.

Sir: I have the honor to send herewith a communication from the Chief of Engineers, dated February 27, with a report by Colonel C. E. Blunt, of the corps of engineers, on the surveys for a ship canal to connect Lakes Erie and Ontario, made in compliance with a joint resolution of Congress, approved March 22, 1867.

Your obedient servant,

EDWIN M. STANTON,
Secretary of War.

Hon. Schuyler Colfax,
Speaker of the House of Representatives.

Headquarters Corps of Engineers,
Washington, D. C., February 27, 1868.

Sir: I transmit herewith the report of Lieutenant Colonel and Brevet Colonel C. E. Blunt, corps of engineers, upon the examination and surveys made in obedience to the provisions of the joint resolution of March 22, 1867, which authorized and directed "surveys, with plans and estimates, to be made by an officer of engineers, for a ship canal to connect Lakes Erie and Ontario, or the navigable waters thereof, of suitable location and dimensions for military, naval, and commercial purposes."

The importance of an uninterrupted water communication between these two lakes for the largest class of vessels was, as early as 1808, considered worthy of the efficient aid of the general government.

In 1826 a survey was made under an association of private individuals, and another, in 1835, by Captain W. G. Williams, corps of topographical engineers, in obedience to a resolution of the House of Representatives.

In the able report made by Captain Williams five different lines, two of which nearly coincide with the Four-mile Creek and the Twelve-mile Creek routes of the present report, were carefully considered and estimated for at the prices of that day. Preference was given to a route near to and debouching into the Niagara river. The five separate routes here presented by Colonel Blunt, as feasible for the canal in question, do not differ as materially in cost as in length.

Upon the shorter, or Lewiston, routes the proposed system of double locks, indispensable from the great amount of lockage required in a short space, makes the cost relatively greater; and of the longer routes, the Four-mile Creek and the Twelve-mile Creek routes have their cost relatively increased by more rock excavation, and more double locks, when compared with the Eighteen-mile Creek route.

The Eighteen-mile Creek route best fulfils the condition of security by being further removed from the frontier, and, as its terminus is fifteen miles further east on Lake Ontario than the average of the others, viewed as a route for commerce, it is that much shorter.

Its greater security against secret enterprise, during and just preceding a war, renders it preferable for commercial, as well as for military and naval purposes.

Were the canal extended from Tonawanda to Buffalo harbor, its extension would not be better protected against an enemy than the river would be. Its extension is therefore deemed unnecessary.

The average cost of the projected canal would be about twelve millions of dollars; and, after a careful examination of the estimated cost of the several projects as given in detail, it appears to be probable that they could not be executed for less sums than those estimated.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier General Engineers, Commanding.

Hon. E. M. STANTON,
Secretary of War.

REPORT AND MEMOIR ON PROPOSED LINES FOR A SHIP CANAL AROUND NIAGARA FALLS, BY LIEUTENANT COLONEL C. E. BLUNT, U. S. ENGINEERS, BREVET COLONEL UNITED STATES ARMY.

UNITED STATES ENGINEER OFFICE,
Oswego, New York, February 6, 1868

SIR: By your official letter of May 8, 1867, the duty of making surveys and estimates for a ship canal to connect Lakes Erie and Ontario, around Niagara Falls, was assigned to me, such surveys and estimates having been ordered by joint resolution of the 40th Congress, approved March 22, 1867.

By a subsequent letter I was authorized—in view of the other important duties connected with my charge of works of defence and harbor improvements in the eastern district of the lake frontier—to obtain the aid of competent civil engineers as assistants, and the names of several were given to me. None of these gentleman having been obtainable, some little delay was caused in consequence, but I at last succeeded in engaging the services of Messrs. James S. Lawrence and Stephen F. Gooding, both men of ability and experience in their profession. Field parties were immediately organized under the personal charge of these gentlemen, and careful transit and level lines run over all the principal lines judged practicable for the canal, with such subsidiary and auxiliary lines as were necessary in connection with them. Borings have been made wherever previous data and information otherwise obtained were not sufficient to determine the nature of the soil and depth of rock when cuttings were found necessary.

The reports of Captain Williams and others have been consulted and compared, and, in general terms, all the information possible bearing upon the subject of the canal has been obtained and used by myself and my assistants.

After consultation with a number of influential persons interested in the canal in connection with previous partial legislation by Congress, and having in view especially the provisions of the bill relating to the subject which is now pending, I decided that it was no part of my duty to make any recommendations as to the proper location of the canal, or even to state any advantage or disadvantage connected with any particular work.

The engineering questions resolve into the item of cost—the commercial ones I do not profess to be particularly competent to discuss; and they involve, moreover, local interests with which an engineer should have no concern; and the military one, involved in the greater or less distance of the line from the Canadian frontier, is, at the same time, now so connected practically, as an argument pro or con, with the same local interests, that any expression of my personal views in relation to it would carry with it an *opinion* affecting the location of the canal, which I think I have no right to give.

Having in view, also, the provisions of the pending bill before alluded to, I have not felt myself at liberty to consider anything but well-known systems and plans of canal construction, and have based all my estimates accordingly upon these well-known data.

Certain projects for an inclined plane and for a single lock or well, to overcome the whole descent at once, have been laid before me by their ingenious originator; but I have not had the time, had I felt it my duty, to investigate them carefully, and, of course, cannot take the responsibility of expressing any professional opinion upon them.

The dimensions of canal and locks, adopted and used in all the estimates, are as follows:

Width of canal at water surface, in earth cutting, 125 feet.
Width of canal at bottom, in earth cutting, 90 feet.
Depth of canal, 14 feet.
Width of canal in rock cutting, sides vertical, 100 feet.
Towing path 6 feet above surface and 15 feet wide.
Slopes, when protected by slope walls, 1¼ base to 1 height.
Earth slopes 1 upon 2.
Length of lock chamber, 275 feet.
Width of lock chamber, 46 feet.
Depth over mitre-sill, 14 feet.
Lift in general, 15 and 16 feet.

I have thought it entirely unnecessary and uncalled for to enter into any topographical description of the well-known section of country through which the proposed canal must pass, nor do I give any statistics relating to the internal commerce which seems to demand its construction. All these matters are well understood. It is even scarcely necessary to remark, in connection with the former subject, that the main difficulties attending the construction of the canal are involved in the descent of the "mountain," the country between that ridge and Lake Ontario being generally level, and canal construction corresponding simply.

The lines for which estimates are submitted are as follows:

No. 1. From steamboat landing at Lewiston, *directly up the mountain* to old Fort Gray, and thence to Schlosser, length, 7.05 miles.

No. 2. From Five mile Meadow, below Lewiston on Niagara river, to Lewiston and Schlosser, length, 9.38 miles.

No. 2 A. From a point fifteen hundred feet south of the steamboat landing at Lewiston, crossing the natural basin in an easterly direction, to the foot of the mountain ridge, thence by line No. 2 to Schlosser, length, 7.803 miles.

No. 3. From the mouth of Four-mile creek, on Lake Ontario, to Schlosser, length, 14.43 miles.

No. 4. From Wilson, at the mouth of Twelve-mile creek, on Lake Ontario, to the Niagara river, between Cayuga and Tonawanda creeks, length, 18 35 miles.

No. 5. From head of Olcott harbor—Eighteen-mile creek—on Lake Ontario, Niagara river, opposite north end of Tonawanda island, length, 25.28 miles.

Besides these six lines, surveys have been made along a line, No. 5 A, connecting Tonawanda creek and Buffalo harbor, and with line No. 5 at the twentieth mile, which will add about fifteen miles in length, and $11,000,000 in expense to either the Wilson or Olcott route; that is, the cost of the interior line, terminating at Buffalo harbor, would be $23,000,000.

The local charge of the surveys for the lines debouching into the Niagara river, Four-mile creek, and Wilson's creek, has been with James S. Lawrence, esq., of Youngstown, civil engineer. Stephen F. Gooding, esq., of Lockport, civil engineer, has been in local charge of the surveys for the Eighteen-mile creek, or Lockport line, and the line extending to Buffalo harbor. They have performed their duties with great energy and ability, and the data upon which the estimates for the various lines are based, as obtained by themselves and the parties under their immediate charge, may, it is confidently believed, be fully relied upon.

With these preliminary remarks, I submit the following memoirs and estimates for each of the routes I have referred to.

No. 1.—Lewiston Line.

Length 7.05 miles; 21 lifts. Estimated cost, $12,095,438.

This line commences at a point on the Niagara river about seven hundred feet north of the steamboat landing, where the bank is bold, and fifty feet above the river. It is traced along a depression at the foot of the Lewiston ridge twelve hundred feet in a southeast direction, from thence three thousand feet along the foot of the ridge, and crossing the same to the Lewiston and Niagara Falls railroad; thence in a southerly direction ascending the mountain ridge nearly at right angles to its face, a distance of fourteen hundred feet, to Fort Gray, three hundred and thirty five feet above the river.

From Fort Gray the line continues for two miles, nearly parallel to the river, passing east of the Roman Catholic seminary and the Lewiston and Niagara Falls railroad; thence following the valley of Bloody run and a southeasterly course one and a half mile, crosses the Lockport and Niagara Falls railroad about three-quarters of a mile east of Suspension bridge, at the highest point on the line, the elevation being three hundred and fifty-two feet. From this point there is a gradual descent into the valley of Gill creek, which the line strikes about one mile from the crossing of the railroad, and follows to its mouth at Schlosser, on the Niagara river, three miles above the falls, the whole distance being $7\frac{045}{1000}$.

The difference between the surface of water of the Niagara river at Lewiston and the Niagara river at Schlosser is 316 feet. This has been divided into twenty-one lifts; twenty of fifteen feet, and one of sixteen feet.

Commencing at the river at Lewiston, the line ascends the banks by four double and consecutive locks, and is continued by a short level of eleven hundred feet to the second tier of three double and consecutive locks, and a basin of three hundred and seventy-five feet, to the third tier of four double and consecutive locks, and a short basin, attaining an elevation of one hundred and fifty-one feet; at this point the Lewiston and Niagara Falls railroad is crossed, for which a stone arch must be built, through which the railroad will pass under the canal. Up to this point the rock cutting is light, but the line here entering the mountain ridge nearly at right angles to its face, a heavy rock thorough cut is encountered, the greatest depth of which is one hundred and thirty-eight feet, and averaging seventy-six feet for a distance of three thousand feet; in this distance there are two tiers of five double and consecutive locks, with an intermediate basin, attaining an elevation of three hundred and two feet, (which is the elevation of the bottom of the canal from this point to its entrance into the Niagara river at Schlosser.) From the commencement of this level the line continues in thorough cut to its termination, the first three miles to the summit having an average cut of thirty-five feet, three-fourths of which is rock.

A pivot or swinging bridge will be required for the railroad crossing at this point. The cutting on the next two miles is lighter, and averages twenty-seven feet, one-fifth only of which is rock; the last half mile averages seventeen feet cutting, and is all earth. Near the river the line crosses the Buffalo and Niagara Falls railroad, which will require a pivot or swing bridge.

A guard lock and dam will be required at the river.

No. 2.—Lewiston Line.

Length 9 39 miles; 21 lifts. Estimated cost, $11,128,438.

This line commences at the Five-mile Meadow, two miles north of Lewiston. This meadow has an area of about thirty acres, and is elevated fifteen feet above the river, affording facilities for the construction of a basin or harbor at this point. The line is traced from the river bank in a southeasterly direction, and ascends to the table land eighteen hundred feet from its commencement, and is continued on the same course two miles, over gradually ascending ground, to a point east of Lewiston, and near the academy; thence southerly three-quarters of a mile to the foot of the mountain ridge, one hundred and fifty feet above the river. At this point the course is changed to southwest, the line ascending the ridge obliquely one mile to Fort Gray, three hundred and thirty feet above the river. From Fort Gray the line runs for two miles nearly parallel to the river, over undulating and gradually rising ground, passing east of the Roman Catholic seminary and the Lewiston and Niagara Falls railroad, to a point near the Devil's Hole; thence along the valley of Bloody run and a southeasterly course one mile to the summit, three hundred and fifty-two feet above the river, and crossing the Lockport and Niagara Falls railroad, descending gradually for two miles into the valley of Gill creek, along which the line continues to its mouth on the Niagara river, three miles above the falls. The length of this line is $9\frac{39}{100}$ miles.

The difference between the surface of water of the Niagara river at the Five-mile Meadow and at Schlosser, three miles above the falls, is three hundred and sixteen feet. This has been divided into twenty-one lifts; twenty of fifteen feet each, and one of sixteen feet.

Commencing on the bank of the river at the Five-mile Meadow with a double lock of sixteen feet lift, and a basin of five hundred feet in length, the line reaches the slope from the meadow to the table land, which it ascends by five double and consecutive locks, attaining an elevation of seventy-seven feet, and a distance from the river of two thousand feet. From this point there is a level of one mile over favorable ground to Lock No. 7; thence the line continues over similar ground another mile to Lock No. 8, at the foot of the south ridge, which it ascends by three double locks; thence with a level of eleven hundred feet, a double lock, No. 11, and a basin of six hundred feet to the foot of the mountain ridge, attaining an elevation of one hundred and eighty-one feet; at this point begins the heavy work, it being necessary to cut deep into the mountain side to obtain secure footing for the walls of locks and basins. The line is carried obliquely up the mountain to Fort Gray by two tiers of four and five double and consecutive locks, with an intermediate basin, to an elevation of three hundred and two feet, being the level of the bottom of the canal, to its termination at Schlosser.

From Fort Gray the line continues in thorough cut to its termination, the first half mile having an average cutting of twenty-eight feet, of which four-fifths is rock; the next three miles to the summit have an average cutting of thirty-five feet, three-fifths of which is rock. At this point the Lockport and Niagara Falls railroad is crossed, and a pivot or swing bridge will be required. On the next two miles the cutting is lighter, averaging twenty-seven feet, one-fifth of which is rock. The last half mile has an average cut of seventeen feet, and is all earth. Near the river the line crosses the Buffalo and Niagara Falls railroad, and a pivot or swing bridge will be required.

A guard lock and dam will be required at the entrance to the canal.

[For variations on this line see Memoir No. 2 *a*.]

No. 2 *a*.—LEWISTON LINE.

Length 7.8 miles, 21 lifts. Estimated cost, $11,031,916.

This line commences at a point on the Niagara river fifteen hundred feet south of the steamboat landing, and fifty-three feet above the water it takes an easterly direction, crossing a low sandstone ridge into and across the "natural basin," to a point at the foot of the mountain ridge one mile from its commencement, and one hundred and fifty feet above the river. Here the course is changed to southwest, (and thence the line is identical with the Lewiston line No. 2.)

Commencing at the river at Lewiston, the line ascends the bank by four double and consecutive locks, and is continued by a short level or basin to the sandstone ridge, which it ascends by four double and consecutive locks to the "natural basin;" thence across the basin (by a canal in embankment, the surface being one hundred and twenty-one feet above the river) to its eastern bank or margin, which it ascends by four double and consecutive locks to a basin six hundred feet long and one hundred and eighty-one feet above the river. (From this point line No. 2 *a* and line No. 2 are identical.)

No. 3.—FOUR-MILE CREEK LINE.

Length 14.43 miles, 21 lifts. Estimated cost, $12,673,520.

This line commences at the mouth of a creek four miles east of the Niagara river, on Lake Ontario, and follows the channel of the creek for one mile, thence in a southerly direction on the table land, with a gradual ascent over very favorable ground, eight miles to the mountain ridge near Miller's sulphur spring; thence in a southwest direction to the brow of the ridge, and then turning to the southeast, descending into the valley of Fish creek, which it crosses, and reaches the summit at the end of the ninth mile. Descending into the valley of Gill creek the line follows its course to the Niagara river at Schlosser, three miles above the Falls, making the whole distance $14\frac{43}{100}$ miles.

The difference between the surface of water of Lake Ontario, at the mouth of Four-mile creek and the Niagara river at Schlosser, is 316.04 feet; deducting the .04 for variation of level, leaves the difference of three hundred and sixteen feet. This has been divided into twenty-one lifts, twenty of fifteen feet each and one of sixteen feet.

Commencing at the mouth of the creek, with a single lock of sixteen feet lift, the line takes a southerly course, and at the fourth lock on the second mile attains an elevation of forty-six feet, being the general level of the ground at this distance from the lake. From this point the ground rises very gradually to the end of the seventh mile, its formation being favorable for the economical construction of the canal and the use of single locks, seven of which are used with levels varying from half a mile to three miles in length. On the eighth mile, and with three of double and consecutive locks, (two tiers of five each and one tier of four,) with two intervening basins, the line ascends the mountain ridge, obtaining an elevation of three hundred and two feet, being the level of the bottom of the canal to its termination at the Niagara river. At the commencement of the ninth mile the line enters a heavy cutting, which increases for one mile until the summit is reached seventy-seven feet above the bottom of the canal. From this point the ascent is gradual, and the cutting decreases so that on the ninth, tenth, and eleventh miles the cutting averages sixty feet, three-fourths of which is rock. On the twelfth mile the line crosses the Lockport and Niagara Falls railroad, at which point a pivot or swing bridge will be required, and descends gradually, with an average cutting in the twelfth, thirteenth, and fourteenth miles, of thirty feet, one-third of which is rock. In the last half mile the line crosses the Buffalo and Niagara Falls railroad (requiring a pivot or swing bridge,) and terminating at the Niagara river with an average cutting of eighteen feet, mostly earth. At this point a guard-lock for the canal and a dam to form a harbor in the Niagara river will be required. The pond at the mouth of Four-mile creek may be formed into an inner harbor at a moderate expense. The outer harbor will be formed of two parallel piers of crib work filled with stone, extending into the lake to fifteen feet of water, a distance of one thousand feet.

This Four-mile creek line coincides nearly with Captain Williams's line No. 2.

No. 4.—Wilson or Twelve-mile Creek Line.

Length, 18.35 miles, 21 lifts. Estimated cost, $13,993,638.

This line commences at the mouth of Twelve-mile creek, and following its course about a half a mile, the line reaches the table land, and thence in a southerly course for nine and a half miles over gently rising ground, very favorable for the location of a canal, it reaches the foot of the mountain ridge. At this point the ascent commences, and a second table land is passed; continuing a southerly course, the line crosses the Pekin road, and half a mile further the summit is reached, the line descending into the valley of Cayuga creek to the Lockport and Niagara Falls railroad; from thence it takes a southwest course along the valley of the creek to Berghott; thence, nearly on the same course, to its termination at a point on the Niagara river, two miles east of Cayuga creek; the whole distance being $18\frac{35}{100}$ miles.

The difference between the surface of water of Lake Ontario, at the mouth of Twelve-mile creek, and the Niagara river at the point where this line terminates, is $317\frac{58}{100}$ feet; deducting $\frac{58}{100}$ for variation of levels, leaves the difference 317 feet. This has been divided into twenty-one lifts, of which nineteen will be fifteen feet each, and two of sixteen feet.

Commencing at the mouth of the creek with a single lock of sixteen feet lift, and locating two others, one of sixteen feet, and the other fifteen feet lift, with short levels between, on the first half mile, brings the bottom of canal to thirty-three feet, being the general elevation of the ground at this distance from the lake. From this point to the foot of the mountain ridge, a distance of nine miles, the inclination is gradual, attaining an additional elevation of one hundred and thirty-five feet, which is overcome by the use of nine single locks. From this point the line ascends the mountain ridge to a second table land at an elevation of two hundred and seventy-three feet above the lake, which is overcome by a tier of seven double and consecutive locks. On this table land there is a level of half a mile, and then two more double and consecutive locks of fifteen feet lift, attaining an elevation of three hundred and three feet, being the level of the bottom of canal from this point to the Niagara river.

From the lake to this point the ground is favorable to an economical construction of a canal, there being a greater number of *single* locks than on the line No. 3, and less rock excavation than on either line No. 1, 2, or 3 in surmounting the ridge; but from this point deeper cutting is found than on either of the other lines, the greatest depth of rock cutting being ninety-two feet, and the average for the first three miles sixty-five feet, three-fourths of which is rock.

The next two miles average forty-one feet, the largest portion being rock; from thence to the river, two and one-third miles, the average cutting is twenty-seven feet, with but little rock. This line crosses the two railroads that are crossed by the other lines, for which pivot or swing bridges will be required.

A guard-lock and dam will be required at the termination of the canal in the Niagara river.

The direction of this line may be so changed as to reduce the river navigation two miles without materially increasing the length of the canal, or the cost of its construction.

The pond at the mouth of Twelve-mile creek may be made into a good interior harbor.

The exterior harbor will be formed by building two parallel piers of crib-work, filled with stone, extending into the lake to fifteen feet water, and a distance of one thousand feet.

Considerable portions of the lines surveyed south of the mountain ridge being through swamps and woodlands, and very thinly inhabited, it was impracticable to obtain by mere inquiry reliable data for estimating the rock cutting. Correct information on this point being absolutely necessary as a basis for trustworthy estimates, borings were taken to the rock at short distances along those lines on which estimates are made.

In addition to the lines which have been thus described, and for which estimates are given, a number of trial lines were examined, but being found less advantageous estimates have been confined to those now given.

It will be observed that the "natural basin" near Lewistown, which is a feature of one of Captain Williams's notes, has not been made use of, or considered in any of the projects herewith submitted.

No advantage commensurate with the increased cost was thought to be derived from its introduction into the plan. Both of the two shorter routes have been in consequence carried directly into the Niagara river.

They coincide in general with those of Captain Williams.

No. 5.—Olcott, or Eighteen-mile Creek Route.

Length, 25.28 miles. Estimated cost, $12,893,170.

The line of survey begins at the head of Olcott harbor, on Lake Ontario, eighteen miles east from the mouth of Niagara river, following the channel of the Eighteen-mile creek (the course of which is nearly south and very direct) for $3\frac{7}{8}$ miles; then leaving the creek, follows a valley diverging somewhat to the west; ascending gradually, reaches in $1\frac{1}{2}$ mile the table land, over which it passes for $5\frac{3}{4}$ miles nearly south to the foot of the mountain ridge, when it enters another valley or gulf $2\frac{1}{8}$ miles in length, varying in width from 80 to 300 feet on the bottom, which is gradually ascending with steep banks on both sides; this is followed to its head, where the mountain ridge is encountered. From the head of the gulf the line follows a slight depression in the ridge, leading in a tolerably direct course west of south for 4 miles to the east end of Beech Ridge; thence by an almost direct line nearly southwest to the Niagara river, opposite the north end of Tonawanda island, about $\frac{7}{8}$ of a mile north of the mouth of Tonawanda creek, making the whole distance 25 miles 22 $\frac{34}{100}$ chains.

The difference between the ordinary low-water surface of Lake Ontario and the Niagara river at Tonawanda we make $320\frac{22}{100}$ feet, which has been divided into twenty-one lifts, sixteen of which will be fifteen feet each, and five of sixteen feet.

By the use of four locks and dams, and a comparatively small amount of excavation, the channel of Eighteen-mile creek for the distance of $3\frac{7}{8}$ miles will be in good condition for the use we propose, with very little other expense. In the next distance of $1\frac{1}{2}$ mile four locks will be required, and generally but one bank, with dams at the locks forming basins from 200 to 400 feet in width. The last of the locks above mentioned will be at the north end of a level about $5\frac{1}{2}$ miles long, so located that for most of its length the excavation will be just sufficient to form the banks. On this level will be required (to pass a branch of the Eighteen-mile creek) the only culvert necessary on the line.

At the south end of this level is located lock No. 9, at the entrance to the "gulf" along which are distributed the remaining twelve locks, numbered consecutively from 10 to 21 inclusive, all separate except Nos. 12 and 13 combined, and 20 and 21 also combined.

Lock No 21 will be at the commencement of the heavy cutting through the mountain ridge, which for the first two miles is mostly solid rock, needing a depth of cutting of 55 feet, over 50 feet of which is rock; from this summit, which is 1½ mile from the "head of the gulf," the surface gradually descends towards the southwest to the river; the surface of the rock dipping more rapidly in the same direction, disappears in about three miles from the "head of the gulf."

The dimensions of the canal estimated on is for 14 feet depth of water, 100 feet wide, in rock cutting; in earth, 90 feet wide on bottom, with slopes (protected by slope walls) of 1¼ foot, horizontal base, to 1 foot vertical, to the top of the towing-path. Banks of earth, when not protected by slope walls, to be two feet horizontal to one foot vertical. Towing-path to be fifteen feet wide, and berme twelve.

The estimate for locks provides for a chamber 275 feet long from angle to angle of mitre-sills, forty-six feet wide, with fourteen feet depth of water on the mitre-sills.

In all cases, except when locks are combined, provision is made for basins between them, not less than 500 feet long. In the two cases when the locks are combined the estimate includes the cost of double sets.

A guard-lock, with walls nineteen feet high, to be located in the vicinity of Niagara river, to protect against occasional high water in the river, and to allow the water to be drawn out of the canal when necessary for repairs, &c., is included in the estimate.

For local crossings, pivot swing-bridges resting on a centre piece are estimated, providing for a water-way on each side, of fifty feet.

No. 5 *a*.—Line from Tonawanda Creek to Buffalo Harbor.

Length, fifteen miles; estimate, $11,000,000—in addition to the length and cost of the Olcott or Wilson lines.

From Tonawanda creek to the south side of Ellicott creek the line adopted for bottom is fourteen feet below the surface of water in the same, as used for the Erie canal, which is 324.144 above the surface of Lake Ontario.

On the south side of Ellicott creek a lock of four-feet lift is estimated, the cost of which is assumed as the same as for the guard-lock, to be located on the main line, near the Niagara river.

From the lock to Buffalo creek the bottom line is sixteen feet below the surface of Buffalo harbor, 327.759 above Lake Ontario.

The estimate includes nothing for deepening Buffalo creek between the point where this line intersects it and Buffolo harbor.

There is also appended an estimate of the cost of deepening the Tonawanda creek from the mouth of Sawyer's creek to the point where the above estimated line diverges from the same, the distance being 216 chains.

Nearly all the work required is for excavating a bar which covers a distance of thirty chains in length, the water, except at this bar, generally averaging from eighteen to twenty-four feet deep.

There is also submitted an estimate for a canal of the same dimensions as on the line from Olcott to the Niagara river, diverging from that line at the twentieth mile, and intersecting the Tonawanda creek at the mouth of Sawyer's, the line following the general direction of the east branch to its junction with its west branch; thence, by the main channel, to the Tonawanda.

The bottom line being raised four feet above that estimated for the main line, would, if adopted, consequently diminish the quantity of excavation on the main line between the thirteenth and twentieth miles, as follows: earth excavation, 731,000 cubic yards; rock excavation, 205,000 cubic yards. The additional lockage of four feet would increase the expense $42,120.

The total estimate on the main line, from the twentieth mile to the river, would be dispensed with in case lines above estimated on should be adopted.

Niagara ship canal, 1867, *route No.* 1.—*From steamboat landing at Lewis*

Miles.	Excavation of earth.			Excavation of rock.			Embankment.			Lining and gravelling.		
	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.
	Cub. yds.	*Cts.*		*Cub. yds.*				*Cts.*		*Cub.yds.*	*Cts.*	
1	313, 469	25	$78,367 25	58, 730	$1 25	$73, 412 50	70, 000	25	$17, 500	5, 300	50	$2, 650
2	202, 297	25	50,574 25	1, 346, 499	1 25	1, 683, 117 50	....	....	....	2, 600	50	1, 300
3	366, 187	25	91,546 75	392, 581	1 25	490, 726 25	....	....	....	2, 600	50	1, 300
4	339, 637	25	84,909 25	470, 128	1 25	587, 660 00	....	....	....	2, 600	50	1, 300
5	263, 230	25	65,807 50	611, 771	1 25	764, 713 75	....	....	....	2, 600	50	1, 300
6	526, 844	25	131,711 00	260, 437	1 25	325, 546 25	....	....	....	5, 100	50	2, 550
7	390, 219	25	97,554 75	116, 645	1 25	145, 806 25	....	....	....	8, 000	50	4, 000
	2, 401, 883	....	600,470 75	3, 256, 791	......	4, 070, 982 50	70, 000	....	17, 500	28, 800	....	14, 400

Niagara ship canal, 1867, *route No.* 2.—*From Five-mile Meadow, by Lewis*

Miles.	Excavation of earth.			Excavation of rock.			Embankment.			Lining and gravelling.		
	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.
	Cub. yds.	*Cts.*		*Cub. yds.*			*Cub.yds.*	*Cts.*		*Cub.yds.*	*Cts.*	
1	224, 042	25	$56,010 50	....	......	....	41, 000	25	$10, 250	8, 100	50	$4, 500
2	151, 073	25	37,768 25	....	......	....	18, 000	25	4, 500	10, 400	50	5, 200
3	152, 290	25	38,072 50	158, 557	$1 25	$198, 196 25	76, 000	25	19, 000	6, 200	50	3, 100
4	207, 913	25	51,978 25	406, 996	1 25	508, 745 00	74, 000	25	18, 500	3, 200	50	1, 600
5	325, 258	25	81,314 50	328, 423	1 25	410, 528 75	....	....	....	2, 600	50	1, 300
6	396, 462	25	99,115 50	500, 095	1 25	625, 118 75	....	....	....	2, 600	50	1, 300
7	269, 692	25	67,423 00	542, 560	1 25	678, 200 00	....	....	....	2, 660	50	1, 300
8	418, 754	25	104,688 50	411, 440	1 25	514, 300 00	....	....	....	4, 300	50	2, 150
9	435, 940	25	108,985 00	185, 967	1 25	232, 458 75	....	....	....	6, 600	50	3, 300
38.100	153, 036	25	38,259 00	....	......	....	....	....	....	5, 800	50	2, 900
	2, 734, 460	....	683,615 00	2, 534, 038	......	3,167,547 50	219, 000	....	52, 250	52, 400	....	26, 200

ton to Schlosser, 7.045 *miles; summary of quantities per mile and estimated cost.*

Rip-rap and slope walls.			Bridges.		Locks.		Bailing, draining, and clearing.	Total.
Quantity.	Price.	Amount.	Number.	Amount.	Number.	Amount.		
Cub. yds.								
$5, 200	$1 50	$7, 800	1 common, 1 railroad.	$29, 600	12 double...	$3, 328, 560	$3, 000	$3, 698, 089 75
....	......	....	Concrete	157, 200	9 double . ..	2, 496, 420	2, 000	4, 233, 411 75
....	......	....	1 common...	6, 600	....	....	2, 000	592, 173 00
....	......	....	1 common...	8, 400	....	....	2, 000	684, 269 25
....	......	....	1 common, 1 railroad.	27, 200	....	....	2, 500	861, 521 25
4, 900	1 50	7, 350	1 common...	7, 000	....	....	3, 000	477, 157 25
10, 400	1 50	15, 600	2 common, 1 railroad, combined.	23, 800	Guard-lock .	114, 415	2, 600	403, 776 00
20, 500	......	30, 750	....	259, 800	....	5, 939, 395	17, 100	10, 950, 398 25
To which add for a dam and dredging in the Niagara river at Schlosser								50, 000 00
Add also 10 per cent. for contingencies								1, 095, 039 75
Total								12, 095, 438 00

ton, to Schlosser, 9.38 *miles; summary of quanties per mile and estimated cost.*

Rip-rap and slope walls.			Bridges.		Locks.		Bailing, draining, and clearing.	Total.
Quantity.	Price.	Amount.	Number.	Amount.	Number.	Amount.		
Cub. yds.								
10, 600	$1 50	$15, 900	3 common ...	$13, 800	6 double....	$1, 664, 280	$2, 000	$1, 766, 290 50
15, 100	1 50	22, 650	2 common ...	9, 200	1 double....	277, 380	800	357, 498 25
6, 900	1 50	10, 350	2 common ...	9, 200	9 double....	2, 496, 420	2, 000	2, 776, 338 75
1, 200	1 50	1, 800	....	....	5 double....	1, 386, 900	2, 000	1, 971, 523 25
....	......	....	1 common ...	6, 600	....	....	2, 000	501, 743 25
....	......	....	1 common ...	8, 400	....	....	2, 000	735, 934 25
....	......	....	1 common, 1 railroad.	27, 200	....	....	2, 500	776, 623 00
3, 300	1 50	4, 950	1 common ...	7, 000	....	....	3, 000	636, 088 50
7, 800	1 50	11, 700	1 common ...	5, 300	....	....	2, 500	364, 243 75
6, 100	1 50	9, 150	1 common, 1 railroad, combined.	18, 500	Guard-lock .	114, 415	1, 800	185, 024 00
51, 000	......	76, 500	....	105, 200	....	5, 939, 395	20, 600	10, 071, 307 50
To which add for a dam and dredging in the Niagara river at Schlosser								50, 000 00
Add also 10 per cent. for contingencies								1, 007, 130 50
Total								11, 128, 438 00

Niagara ship canal, 1867, *route No.* 2 *A.—From a point on the Niagara river natural basin in an easterly direction to the foot of the mountain ridge, thence*

Sections.		Excavation of earth.			Excavation of rock.			Embankments.			Lining and gravelling.		
Number.	Feet.	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.
		Cub. yds.	*Cts.*		*Cub. yds.*			*Cub. yds*	*Cts.*		*Cub. yds*	*Cts.*	
1	3, 800	261, 000	25	$65, 250 00	....	......	....	120,000	25	$30, 000	2, 100	50	$1, 050
2	3, 500	264, 000	25	66, 000 00	128, 000	$1 25	$160, 000 00	....	....	....	2, 600	50	1, 300
3	5, 300	207, 913	25	51, 978 25	406, 996	1 25	508, 745 00	74,000	25	18, 500	3, 200	50	1, 600
4	5, 200	325, 258	25	81, 314 50	328, 423	1 25	410, 528 75	....	....	....	2, 600	50	1, 300
5	5, 300	396, 462	25	99, 115 50	500, 095	1 25	625, 118 75	....	....	....	2, 600	50	1, 300
6	5, 300	269, 692	25	67, 423 00	542, 560	1 25	678, 200 00	....	....	....	2, 600	50	1, 300
7	5, 300	418, 754	25	104, 688 50	411, 440	1 25	514, 300 00	....	....	....	4, 300	50	2, 150
8	5, 500	435, 940	25	108, 985 00	185, 967	1 25	232, 458 75	....	....	....	6, 600	50	3, 300
9	2, 000	153, 036	25	38, 259 00	....	1 25	....	....	....	....	5, 800	50	2, 900
	41, 200	2, 732, 055	....	683, 013 75	2, 503, 481	......	3,129,351 25	194,000	....	48, 500	32, 500	....	16, 200

Niagara ship canal, 1867, *route No.* 3.—*From Four-mile Creek to*

	Excavation of earth.			Excavation of rock.			Embankment.			Lining and gravelling.		
Miles.	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.
	Cub. yds.	*Cts.*		*Cub. yds.*			*Cub. yds*	*Cts.*		*Cub. yds*	*Cts.*	
1	173, 861	25	$43, 465 25	....	......	....	26, 000	25	$6, 500	7, 300	50	$3, 650
2	173, 171	25	43, 292 75	....	......	....	57, 000	25	14, 250	9, 300	50	4, 650
3	175, 368	25	43, 842 00	....	......	....	61, 000	25	15, 250	10, 100	50	5, 050
4	43, 533	25	10, 883 25	....	......	....	178, 000	25	44, 500	10, 900	50	5, 450
5	105, 886	25	26, 471 50	....	......	....	50, 000	25	12, 500	10, 900	50	5, 450
6	189, 584	25	47, 396 00	....	......	....	....	....	....	10, 400	50	5, 200
7	143, 330	25	35, 832 50	....	......	....	39, 000	25	9, 750	10, 500	50	5, 250
8	149, 527	25	37, 381 75	53, 914	$1 25	$67, 392 50	162, 000	25	40, 500	4, 800	50	2, 400
9	325, 713	25	81, 428 25	887, 662	1 25	1, 109, 577 50	....	....	....	2, 600	50	1, 300
10	379, 772	25	94, 943 00	1, 166, 233	1 25	1, 457, 791 25	....	....	....	2, 600	50	1, 300
11	457, 571	25	114, 392 75	806, 327	1 25	1, 007, 908 75	....	....	....	2, 600	50	1, 300
12	410, 770	25	102, 692 50	437, 575	1 25	546, 968 75	....	....	....	2, 600	50	1, 300
13	521, 500	25	130, 375 00	203, 732	1 25	254, 665 00	....	....	....	6. 900	50	3, 450
14	542, 951	25	135, 737 75	103, 121	1 25	128, 901 25	....	....	....	6, 400	50	3, 200
43. 100	234, 316	25	58, 579 00	1, 480	1 25	1, 850 00	....	....	....	6, 200	50	3, 100
	4, 026, 853	....	1, 006, 713 25	3, 660, 044	......	4, 575, 055 00	573, 000	....	143, 250	104, 100	....	52, 050

fifteen hundred feet south of the steamboat landing at Lewiston, crossing the by line No. 2 *to Schlosser,* 7.803 *miles; summary of quantities and estimated cost.*

Rip-rap and slope wall.			Bridges.		Locks.		Balling, draining, and clearing.	Total.
Quantity.	Price.	Amount.	Number.	Amount.	Number.	Amount.		
Cub. yds.								
6, 500	$1 50	$9, 750	1 common, 1 railroad,	$27, 400	8 double....	$2, 219, 040	$2, 000	$2, 354, 490 00
3, 300	1 50	4, 950	1 common ...	4, 600	8 double....	2, 219, 040	2, 000	2, 457, 890 00
1, 200	1 50	1, 800	....	....	5 double....	1, 386, 900	2, 000	1, 971, 523 25
....	......	....	1 common ...	6, 600	....	....	2, 000	501, 743 25
....	......	....	1 common ...	8, 400	....	....	2, 000	735, 934 25
....	......	....	1 common, 1 railroad.	27 200	....	....	2, 500	776, 623 00
3, 300	1 50	4, 950	1 common ...	7, 000	....	....	3, 000	636, 088 50
7, 800	1 50	11, 700	1 common ...	5, 300	....	....	2, 500	364, 243 75
6, 100	1 50	9, 150	1 common, 1 railroad, combined.	18, 500	Guard-lock .	114, 415	1, 800	185, 024 00
28, 200	......	42, 300	....	105, 000	....	5, 939, 395	19, 800	9, 983, 560 00

To which add for a dam and dredging in the Niagara river at Schlosser	50, 000 00
Add also 10 per cent. for contingencies	998, 356 00
Total..	11, 031, 916 00

Schlosser, 14.43 *miles; summary of quantities per mile and estimated cost.*

Rip-rap and slope wall.			Bridges.		Locks.		Bailing, draining, and clearing.	Total.
Quantity.	Price.	Amount.	Number.	Amount.	Number.	Amount.		
Cub. yds.								
9, 100	$1 50	$13 650	1 common...	$4, 600	1.16 lift. 2.15 lift.	$531, 015	$2, 500	$605, 380 25
12, 900	1 50	19, 350	1 common...	4, 600	1.15 lift....	174, 665	800	261, 607 75
14, 500	1 50	21, 700	1 common...	4, 600	1.15 lift....	174, 665	800	265, 957 00
16, 000	1 50	24, 000	1 common...	4, 600	....	....	400	89, 833 25
16, 000	1 50	24, 000	1 common...	4, 600	....	....	800	73, 821 50
15, 100	1 50	22, 650	1 common...	4, 600	1.15 lift....	174, 665	800	255, 311 00
15, 200	1 50	22, 800	....	....	1.15 lift....	174, 665	800	249, 097 50
4, 300	1 50	6, 450	1 common...	4, 600	14 double..	3, 883, 320	3, 000	4, 045, 044 25
....	......	....	1 common...	6, 400	....	....	4, 000	1, 202, 705 75
....	......	....	1 common...	7, 000	....	....	3, 000	1, 564, 034 25
....	......	....	1 common...	7, 500	....	....	3, 000	1, 134, 101 50
....	......	....	1 common, 1 railroad.	25, 000	....	....	3, 000	678, 961 25
8, 400	1 50	12, 600	....	....	....	....	3, 500	404, 590 00
7, 400	1 50	11, 100	1 common...	4, 600	....	....	3, 000	286, 539 00
7, 000	1 50	10, 500	1 common, 1 railroad, combined.	18, 500	Guard-lock.	114, 415	2, 000	208, 944 00
125, 900	......	188, 850	....	101, 200	....	5, 227, 410	31, 400	11, 325, 928 25

To which add, for Lake Ontario harbor, two piers of crib-work filled with stone, each one thousand feet long, 20 feet wide, and 18 feet high..........................	135, 000 00
Dredging for piers and channel 1,000 feet × 360 feet × 7. 5 feet = 100,000 cubic yards, at 30 cts.	30, 000 00
Dam and dredging in the Niagara river at Schlosser..................................	50, 000 00
Add also 10 per cent. for contingencies..	1, 132, 592 00
Total	12, 673, 520 00

Niagara ship canal, 1867, *route No.* 4 —*From Wilson, or Twelve-mile Creek, summary of quantities per*

Miles.	Excavation of earth.			Excavation of rock.			Embankment.			Lining and gravelling.		
	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.
	Cub. yds.	*Cts.*		*Cub. yds.*			*Cub.yds.*	*Cts.*		*Cub.yds.*	*Cts.*	
1	251, 097	25	$62, 774 25	....	......	....	57, 000	25	$14, 250	9, 500	50	$4, 750
2	88, 900	25	22, 225 00	....	......	....	185, 000	25	46, 250	10, 000	50	5, 000
3	194, 600	25	48, 650 00	....	......	....	8, 000	25	2, 000	10, 400	50	5, 200
4	82, 500	25	20, 625 00	....	......	....	99, 000	25	24, 750	10, 500	50	5, 250
5	86, 989	25	21, 747 25	....	......	....	97, 000	25	24, 250	10, 500	50	5, 250
6	134, 500	25	33, 625 00	....	......	....	30, 000	25	7, 500	10, 500	50	5, 250
7	140, 490	25	35, 122 50	....	......	....	97, 000	25	24, 250	10, 500	50	5, 250
8	81, 120	25	20, 280 00	....	......	....	103, 000	25	25, 750	10, 400	50	5, 200
9	103, 005	25	25, 751 25	....	......	....	103, 000	25	25, 750	10, 500	50	5, 250
10	218, 694	25	54, 673 50	167, 218	$1 25	$209,022 50	74, 000	25	18, 500	4, 700	50	2, 350
11	416, 266	25	104, 066 50	936, 386	1 25	1,170,482 50	....	....	....	2, 600	50	1, 300
12	376, 545	25	94, 136 25	1, 324, 088	1 25	1,655,110 00	....	....	....	2, 600	50	1, 300
13	274, 094	25	68, 523 50	877, 343	1 25	1,096 678 75	....	....	....	2, 600	50	1, 300
14	250, 504	25	62, 626 00	735, 243	1 25	919,053 75	....	....	....	2, 600	50	1, 300
15	631, 209	25	157, 802 25	362, 119	1 25	452,648 75	....	....	....	2, 600	50	1, 300
16	914, 518	25	228 629 50	57, 022	1 25	71,277 50	....	....	....	8, 100	50	4, 050
17	699, 707	25	174, 926 75	59, 537	1 25	74,421 25	....	....	....	8, 800	50	4, 400
18	631, 146	25	157, 786 50	....	......	....	....	....	....	10, 900	50	5, 450
35.100	186, 054	25	46, 513 50	....	......	....	....	....	....	5, 800	50	2, 900
	5, 761, 938	....	1,440,484 50	4, 518, 956	......	5,648,695 00	853, 000	....	213, 250	144, 100	....	72, 050

to the Niagara river, between Cayuga and Tonawanda Creek, 18.35 *miles; mile and estimated cost.*

Rip-rap and slope wall.			Bridges.		Locks.		Bailing, draining, and clearing.	Total.
Quantity.	Price.	Amount.	Number.	Amount.	Number.	Amount.		
Cub. yds.								
13,300	$1 50	$19,950	1 common...	$4,600	2.16 lift.. 1.15.....	$538,035	$2,000	$646,359 25
14,200	1 50	21,300	1 common...	4,600	1.15 lift.....	174,665	500	274,540 00
15,000	1 50	22,500	....	....	1.15 lift.....	174,665	800	253,815 00
15,300	1 50	22,950	1 common...	4,600	1.15 lift.....	174,665	1,000	253,840 00
15,300	1 50	22,950	....	....	1.15 lift.....	174,665	500	249,362 25
15,300	1 50	22,950	....	....	1.15 lift.....	174,665	900	244,890 00
15,300	1 50	22,950	2 common...	9,200	1.15 lift.....	174,665	500	271,937 50
15,000	1 50	22,500	1 common...	4,600	1.15 lift.....	174,665	500	253,495 00
15,000	1 50	22,950	....	....	1.15 lift.....	174,665	800	255,166 25
4,100	1 50	6,150	1 common...	4,600	1.15 lift.. 7 double.	2,116,325	2,000	2,413,621 00
....	.....	....	2 common...	11,000	2 double....	554,760	3,500	1,845,109 00
....	.....	....	1 common...	4,600	....	....	4,000	1,759,146 25
....	.....	....	1 railroad....	20,000	....	....	3,500	1,190,002 25
....	.....	....	1 common...	9,000	....	....	3,500	995,479 75
....	.....	....	1 common...	7,500	....	....	3,000	622,251 00
10,600	1 50	15,900	1 common...	6,000	....	....	3,500	329,357 00
12,000	1 50	18,000	2 common...	9,000	....	....	3,000	283,948 00
16,000	1 50	24,000	....	....	....	....	3,000	190,236 50
6,100	1 50	9,150	1 common, 1 railroad, combined.	18,500	Guard-lock	114,415	2,000	193,478 50
182,800	.....	274,200	....	118,000	....	4,720,855	38,500	12,526,034 50

To which add for Lake Ontario harbor two piers of crib-work filled with stone, each 1,000 feet long, 20 feet wide, and 18 feet high..........	135,000 00
Dredging for piers and channel 1,000 feet × 360 feet × 7.5 feet = 100,000 cubic yards, at 30 cents..........	30,000 00
Dam and dredging in the Niagara river at outlet of canal..........	50,000 00
Add also 10 per cent. for contingencies..........	1,252,603 50
Total..........	13,993,638 00

Niagara ship canal, 1867, *Eighteen-mile creek, or Olcut route, No. 5.—Tabu*
the whole

Miles.	Excavation of earth.			Excavation of rock.			Embankment.			Lining and gravelling.		
	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.	Quantity.	Price.	Amount.
	Cub. yds.	*Cts.*		*Cub. yds.*			*Cub.yds.*	*Cts.*		*Cub.yds.*	*Cts.*	
1	87, 278	25	$21, 819 50	....	......	....	....	....	....	3, 000	50	$1, 500
2	30, 053	25	7, 513 25	17, 364	$1 25	$21, 705 00	18, 000	25	$4, 500 00	2, 600	50	1, 300
3	13, 307	25	3, 326 75	4, 440	1 25	5, 550 00	15, 000	25	3, 750 00	2, 600	50	1, 300
4	22, 358	25	5, 589 50	....	......	....	42, 000	25	10, 500 00	3, 000	50	1, 500
5	60, 994	25	15, 248 50	....	......	....	81, 067	25	20, 266 75	7, 600	50	3, 800
6	120, 747	25	30, 186 75	....	......	....	73, 468	25	18, 367 00	10, 900	50	5, 450
7	86, 147	25	21, 536 75	....	......	....	31, 438	25	7, 859 50	10, 900	50	5, 450
8	199, 218	25	49, 804 50	....	......	....	....	....	....	10, 900	50	5, 450
9	133, 671	25	33, 417 75	....	......	....	30, 725	25	7, 681 25	10, 900	50	5, 450
10	126, 122	25	31, 530 50	....	......	....	6, 550	25	1, 637 50	10, 900	50	5, 450
11	110, 306	25	27, 576 50	....	......	....	....	....	....	8, 600	50	4, 300
12	37, 824	25	9, 456 00	29, 042	1 25	36, 302 50	18, 000	25	4, 500 00	2, 600	50	1, 300
13	20, 445	25	5, 111 25	101, 358	1 25	126, 697 50	60, 000	25	15, 000 00	2, 600	50	1, 300
14	195, 784	25	48, 946 00	740, 494	1 25	925, 617 50	....	....	....	2, 600	50	1, 300
15	196, 103	25	49, 075 25	1 751, 744	1 25	2, 189, 680 00	....	....	....	2, 600	50	1, 300
16	873, 755	25	218, 438 75	427, 554	1 25	534, 442 50	....	....	....	6, 800	50	3, 400
17	1, 249, 913	25	312, 478 25	....	......	....	....	....	....	10, 900	50	5, 450
18	1, 244, 510	25	311, 127 50	....	......	....	....	....	....	10, 900	50	5, 450
19	1, 201, 328	25	300, 332 00	....	......	....	....	....	....	10, 900	50	5, 450
20	854, 997	25	213, 749 25	....	......	....	....	....	....	10, 900	50	5, 450
21	716, 341	25	179, 085 25	....	......	....	....	....	....	10, 900	50	5, 450
22	696, 945	25	174, 236 25	....	......	....	....	....	....	10, 900	50	5, 450
23	656, 474	25	164, 118 50	....	......	....	....	....	....	10, 900	50	5, 450
24	624, 679	25	156, 169 75	....	......	....	....	....	....	10, 900	50	5, 450
25	574, 799	25	143, 699 75	....	......	....	....	....	....	10, 900	50	5, 450
Chs. 22. 34	143, 266	25	35, 816 50	....	......	....	....	....	....	2, 600	50	1, 300
	10, 277, 364	....	2, 569, 341 00	3, 071, 996	......	3, 839, 995 00	376, 248	....	94, 062 00	199, 800	....	99, 900

lar statement showing by items the estimated cost of each mile, and total cost of work.

Rip-rap and slope walls.			Bridges.		Locks.		Bailing, draining, grubbing, and clearing.	Total per mile.
Quantity.	Price.	Amount.	Number.	Amount.	Number.	Amount.		
Cub. yds.								
3, 800	$1 50	$5, 700	....	....	....	....	....	$29, 019 50
3, 200	1 50	4, 800	1	$4, 600	2	$349, 330	2, 000	395, 748 25
3, 500	1 50	5, 250	1	4, 600	1	174, 665	2, 000	200, 441 75
5, 300	1 50	7, 950	1	4, 600	2	349, 330	1, 000	380, 469 50
13, 000	1 50	19, 500	1	4, 600	2	356, 350	1, 000	420, 765 25
16, 000	1 50	24, 000	....	....	1	174, 665	1, 000	253, 668 75
16, 000	1 50	24, 000	1	4, 600	....	....	1, 000	64, 446 25
16, 000	1 50	24, 000	....	....	....	....	1, 000	80, 254 50
16, 000	1 50	24, 000	1	4, 600	....	....	1, 000	76. 149 00
16, 000	1 50	24, 000	....	....	1 culvert ...	13, 420	1, 500	77, 538 00
12, 000	1 50	18, 000	1	5, 500	....	....	2, 000	57, 376 50
4, 500	1 50	6, 750	1	4, 600	4 single, 4 double, combined	1, 253, 420	1, 000	1, 317, 328 50
4, 100	1 50	6, 150	1	4, 600	5 single, 4 double, combined	1, 428, 085	1, 000	1, 587, 943 75
....	......	....	1 common, 1 railroad.	25, 500	....	....	7, 000	1, 008, 363 50
....	......	....	1	9, 000	....	....	12, 000	2, 261, 005 75
7, 500	1 50	11, 250	....	....	....	....	10, 000	777, 531 25
16, 000	1 50	24, 000	1	8, 000	....	....	8, 000	357, 928 25
16, 000	1 50	24, 000	1	8, 000	....	....	8, 000	356, 577 50
16, 000	1 50	24, 000	1	7, 000	....	....	8, 000	344, 782 00
16, 000	1 50	24, 000	....	....	....	....	7, 000	250, 199 25
16, 000	1 50	24, 000	1	6, 000	....	....	7, 000	221, 535 25
16, 000	1 50	24, 000	1	6, 000	....	....	7, 000	216, 686 25
16, 000	1 50	24, 000	1 common, 1 railroad.	18, 500	....	....	6, 000	218, 068 50
16, 000	1 50	24, 000	1	5, 500	....	....	7, 000	198, 119 75
16, 000	1 50	24, 000	....	....	....	....	6, 000	179, 149 75
2, 200	1 50	3, 300	1 common, 1 railroad.	19, 000	Guard-lock .	114, 415	2, 500	176, 331 50
283, 100	......	424, 650	....	154, 800	....	4, 213, 680	111, 000	11, 507, 428 00

To which add, for Lake Ontario harbor, 2 piers of crib work, filled with stone, each 1,000 feet long, 20 feet wide, and 18 feet high	135, 000 00
Dredging for piers and channel, (rock work,) 1,000 feet × 360 feet × 7.5 feet = 100,000 cubic yards, at 50 cents	50, 000 00
Dam and dredging in the Niagara river, at outlet of canal	50, 000 00
	235, 000 00
Add also for contingencies	1, 150, 742 00
Total	12, 893, 170 00

Niagara Ship Canal.—Line No. 5 (*a.*)

Estimated cost of constructing a canal diverging from the line surveyed between Olcott and Niagara river at Tonawanda, at the twentieth mile and intersecting the Tonawanda creek at the mouth of Sawyer's creek, making the same dimensions as estimated on the above-mentioned line, with surface of water the same as the Tonawanda creek as used for the Erie canal, being four feet higher than the level of Niagara river at the mouth of the creek, the length of the line being 260 *chains.*

1,395,800 cubic yards excavation of earth, at 25 cents per yard	$348,950
48,400 cubic yards slope wall and riprap, at $1 50 per yard	72,600
30,600 cubic yards lining and gravelling, at 50 cents per yard	15,300
2 common road bridges	12,000
1 guard-lock	112,765
Bailing, draining, and clearing	15,000
	576,615

Estimated cost of constructing a ship canal between the Tonawanda and Buffalo creeks, diverging from the Tonawanda to a point two and one half miles above its mouth and intersecting the Buffalo creek at the Union Iron Works, about one-half mile above the crossing of Ohio street bridge, in the city of Buffalo.

6,556,600 cubic yards excavation of earth, at 25 cents per yard	$1,639,150
5,687,200 cubic yards excavation of rock, at $1 25 per yard	8,530,800
86,500 cubic yards slope wall, at $1 50 per yard	129,750
73,300 cubic yards lining and gravelling, at 50 cents per yard	36,600
1 single lock, four-feet lift	112,765
24 common road bridges	171,300
5 railroad bridges	70,000
Bailing, draining, and clearing	160,000
Total	10,850,365

Estimated cost of deepening Tonawanda creek to, provide for fourteen feet depth of water between the mouth of Sawyer's creek and the point where the above estimated line diverges.

40,000 cubic yards excavation of earth, at 25 cents per yard	$10,000

Estimated cost of constructing a guard-lock with walls nineteen feet high, chamber 275 *feet long and forty-six feet wide.*

4,000 cubic yards embankment and lining earth, at 25 cents per yard	$1,000
2,000 cubic yards puddling, at 12 cents per yard	240
1,650 cubic yards concrete masonry, at $4 per yard	6,600
4,850 cubic yards masonry in lock walls, at $18 per yard	87,300
264,000 feet, board measure, timber plank in foundation, at $20 per M	5,280
43,000 feet, board measure, white oak in gates and mitre-sills, at $75 per M	3,225
47,000 feet, board measure, white pine in lining and gates, at $35 per M	1,645
8,500 pounds wrought iron (besides apparatus for opening and closing gates, filling and discharging locks) at 15 cents per pound	1,275
1,500 pounds cast iron, (except as above,) at 10 cents per pound	150
6,000 pounds spikes and nails, at 10 cents per pound	600
Apparatus for opening and closing gates	500
Gates for filling and discharging water	1,600
Bailing, draining, and clearing	5,000
Total	114,415

Estimated cost to construct a single lock 15 *feet lift,* 275 *feet length of chamber,* 46 *feet wide,* 14 *feet depth of water on mitre-sill.*

12,000	cubic yards embankment and lining earth, at 25 cents per yard	$3,000
8,000	cubic yards puddling, at 12 cents per yard	960
1,530	cubic yards concrete masonry, at $4 per yard	6,120
800	cubic yards rubble masonry, at $6 per yard	4,800
8,170	cubic yards masonry in lock walls, at $18 per yard	147,060
253,000	feet, board measure, timber and plank in foundation, &c., at $20 per M	5,060
30,000	feet, board measure, white-oak plank in gates and mitre-sills, at $75 per M	2,250
38,000	feet, board measure, white-pine plank in lining and gates, at $35 per M	1,330
5,000	pounds wrought iron, (besides apparatus for opening and closing gates, filling and discharging locks,) at 15 cents per pound	885
1,000	pounds cast iron, (except as above,) at 10 cents per pound	100
5,000	pounds spike in foundation, gates, &c., at 10 cents per pound	500
4	sets gates for filling and discharging locks, at $275 per set	1,100
4	sets apparatus for opening and closing gates, at $125 per set	500
	Bailing, draining, and clearing	1,000
		174,665
	Additional cost for lock of 16-feet lift; 390 cubic yards masonry in lock walls, at $18 per yard	7,020
	Total	181,685

*Estimated cost to construct two pairs of double-combined locks, (*4 *locks,) each* 15*-feet lift, chamber* 275 *feet long,* 46 *feet wide,* 14 *feet depth of water on mitre-sill.*

16,000	cubic yards embankment and lining earth, at 25 cents per yard	$4,000
10,000	cubic yards puddling, at 12 cents per yard	1,200
4,820	cubic yards concrete masonry, at $4 per yard	19,280
1,200	cubic yards rubble masonry, at $6 per yard	7,200
27,030	cubic yards masonry in lock walls, at $18 per yard	486,540
584,000	feet, board measure, timber and plank in foundations, &c, at $20 per M.	11,680
90,000	feet, board measure, white-oak plank in gates and mitre-sills, at $75 per M.	6,750
136,000	feet, board measure, white-pine plank in lining and gates, at $35 per M	4,760
21,000	pounds wrought iron, (besides apparatus for opening and closing gates, filling and discharging locks, at 15 cents per pound)	3,150
3,000	pounds cast iron, (except as above,) at 10 cents per pound	300
16,000	pounds spikes and nails, at 10 cents per pound	1,600
	Gates for filling and discharging water	3,300
	Apparatus for opening and closing main gates	1,500
	Bailing, draining, and clearing	1,500
	Total	554,760

Estimated cost of constructing a stone culvert of two semicircular arches ten feet in diameter, resting on bench walls two feet high.

4,200	cubic yards excavation of earth, at 25 cents per yard	$1,050
1,300	cubic yards puddling, including material, at 40 cents per yard	520
56,000	feet, board measure, timber and plank in foundation, &c., at $25 per M	1,400
1,000	pounds spikes and nails, at 10 cents per pound	100
450	cubic yards masonry in arch, at $15 per yard	6,350
300	cubic yards masonry in bench walls, abutments, &c., at $10 per yard	3,000
	Bailing, draining, and clearing	1,000
		13,400

Respectfully submitted:

CHARLES E. BLUNT,
Lieut. Col. Engineers, Bvt. Col. U. S. Army.

Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

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